UNPUBLISHED PRELIMINARY DATA - NsG-439

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National Aeronautics and Space Administration

on

Quantitative Investigation of the Mineralogy and Petrography of the Stony and Iron Meteorites - Grant No. NsG439

by

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July 1964 - January 1965

Personnel:

Personnel active on the project during the period were A. R. Ramsden, Project Associate, fulltime; Ralph M. Thorpe, Research Assistant, September-December; and E. N. Cameron, Principal Investigator, part-time.

Work accomplished:

The following subjects were investigated during the period:

1. Reflectivities of kamacites and taenites in iron meteorites at 470, 500, 546, and 589 mμ.
2. Reflectivities of pure iron, pure nickel, γ 80% Ni - 20% Fe alloy, γ 60% Ni - 40% Fe alloy, α 6% Ni - 94% Fe alloy, at 470 mμ, 500 mμ, 546 mμ, and 589 mμ.
3. Reflectivities of schreibersite and cohenite at 470, 500, 546, and 589 mμ.
4. A new kamacite phase, apparently a transition phase, discovered thus far in four meteorites.

5. Quantitative modal analyses of certain iron meteorites in terms of kamacite, taenite, and plessite.

6. Quantitative modal and size analyses of plessites.

~~The first two subjects are to be written up shortly for publi-~~ cation, hence only a summary of results will be given here. Briefly, excellent curves for dispersion of the reflectivity of natural and synthetic kamacites and taenites have been obtained covering the compositions cited. The data show that reflectivity measurements at 546 mμ can be used to determine composition of an unknown taenite, without the ambiguity that attaches to unit cell data. For kamacites, evaluation of curves has been delayed owing to difficulties in preparing α alloys with 2% and 4% Ni, respectively. Gas bubbles in the alloys of these compositions have been a serious problem, but we are hopeful of eliminating the difficulty within a few weeks. Meanwhile reflectivity data for kamacite in 15 iron meteorites have been obtained with data on dispersion of the reflectivity for kamacites in 8 meteorites.

Reflectivity data for schreibersite (one meteorite) and cohenite (three meteorites) at various wavelengths are now at hand. We plan to publish these data shortly. The two minerals are readily distinguishable from reflectivity measurements (Fig. 1). Data for the three cohenites suggest variation in composition. This is a subject for further investigation.

X-ray investigation of kamacites has shown the presence of a new phase, apparently a transition phase, in four iron meteorites. X-ray data index to a tetragonal unit cell. Results are being prepared for publication.

During the period, substantial progress has been made in modal analyses of iron meteorites in terms of kamacite, taenite, and plessite, and study of modal proportions relative to the composition of co-existing kamacite and taenite. This is important, because it will afford a test of the presently accepted subsolidus phase relations between α and γ Fe-Ni alloys. Data from modal analyses, together with published data for bulk compositions of the meteorites investigated, can be used to calculate compositions of coexisting phases. This has been done by us for four meteorites. Electron probe data for six additional meteorites are available in the literature. The two sets of data appear to correlate well. They suggest that revision of the subsolidus curves may be necessary. Additional data on compositions of coexisting phases are to be secured by electron probe in the very near future.

Study of certain iron meteorites has shown textures suggesting exsolution of a separate phase from kamacite. Attempts to determine composition from reflectivity have been made but have proved impractical because the apparent exsolution lamellae are too narrow. Microscopic findings must be tested by electron probe work.

Very recently we have begun a quantitative modal and size analysis of plessites, in an attempt to shed light on the cooling history of the octahedrites. This is difficult work, but first results are encouraging. There appear to be sharp breaks in the textural scale of plessite without change in textural type. The existence of such discontinuities in texture is not readily compatible with slow, progressive cooling of a solid solution. Rather it suggests discrete events (changes in pressure or rate of cooling) that have occurred during the history of the meteorite. The question immediately arises -- do all octahedrites show the same discontinuities, indicative of a common history, or are they features of only a few meteorites? This question clearly merits further investigation.

Work in progress during 1965:

Work in progress during 1965 is partly indicated in the above summary. First priority is assigned to completing, and preparing for publication, material under items 1 to 4 in the list of subjects investigated. Subjects 5 and 6 require extended further investigation, which will be pursued. The quantitative resolution of the components of plessite is regarded as very important. No quantitative evaluation of the phase history of iron meteorites is possible until this has been done.

In addition, we plan further investigation of the optical properties of schreibersite and cohenite, particularly in relation to composition. Finally, quantitative modal analyses are to be extended to cover these two minerals in iron meteorites containing them.

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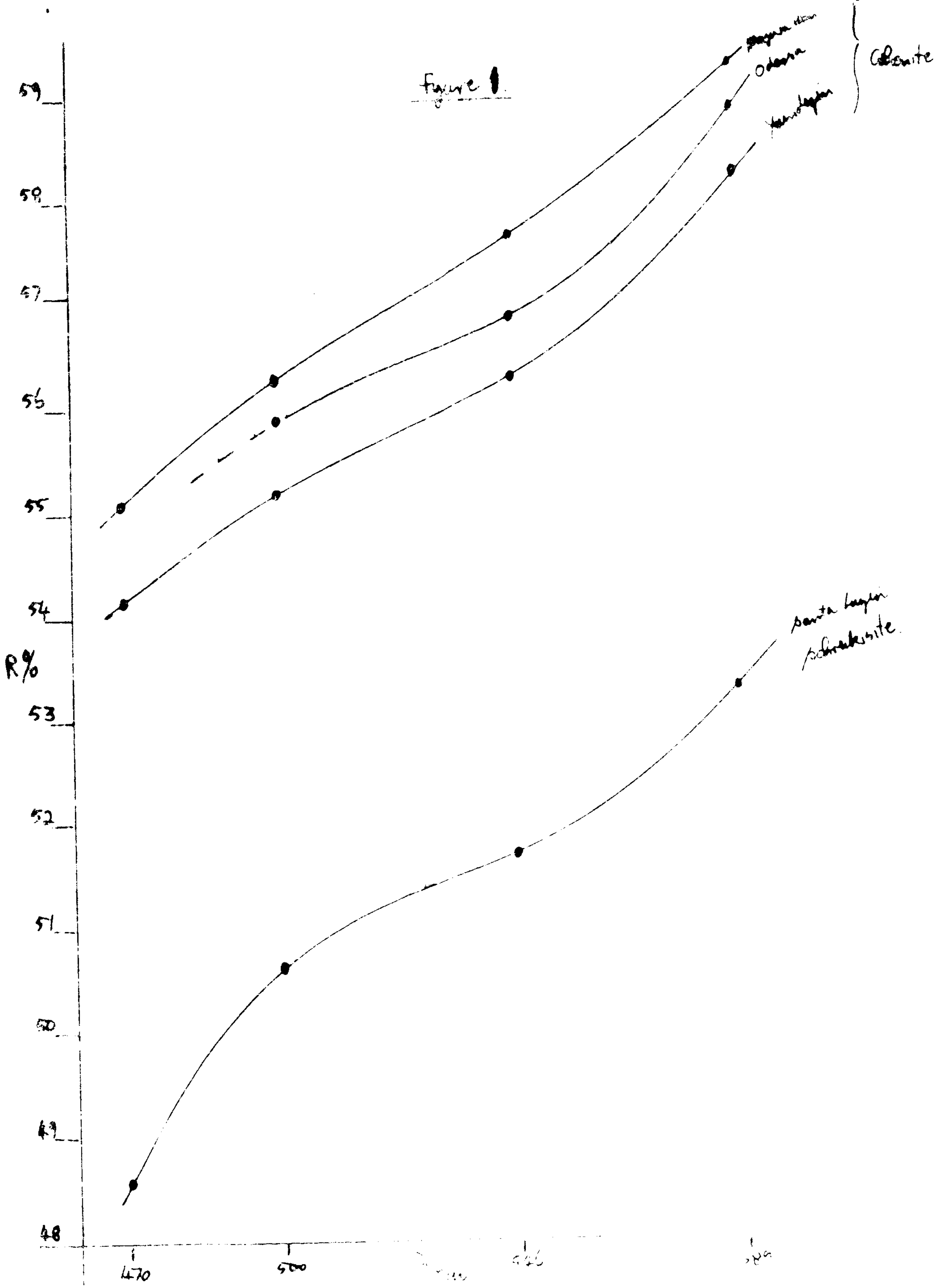

Figure 1.